

# Reasoning, not Recipes

Helping your students develop statistical understanding  
and enjoy the experience!

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Statistics is often presented to students as a series of algorithms to be learnt by heart and applied at the appropriate time to get “the correct answer”. This approach, while it may in fact produce the right answer, has been shown to be minimally effective at helping students understand the underlying statistical concepts. For many years statistics educators have argued that it is the language of statistics not the computations, that matter. As Holmes (2003, p. 452) noted, “Statistics is not just a set of techniques, it is an attitude of mind in approaching data”.

Statistical concepts are much more easily grasped when the data used is real and the context is real to the students (see for example Nicholson, Ridgway and McCusker, 2006; Jordan and Haines, 2006). The CensusAtSchool (C@S) resource from the Australian Bureau of Statistics (ABS) is real data which is interesting and engaging for students. C@S data was collected from Australian students in 2006 and 2008 and is available free from the ABS website ([www.abs.gov.au/censusatschool](http://www.abs.gov.au/censusatschool)). Data collection is now open for 2010, and from now on will be annual.

The C@S questionnaire contains questions relating to physical characteristics (such as height, arm span, foot size), behaviour (amount of sleep, breakfast habits, favourite sport) and attitudes (water use, pollution, bullying) of students. There is also an interactive concentration game and a reaction time game. Over 100 000 students submitted their responses in 2006 and 45 000 in 2008. All this data is available for free download from the website. The 2010 data will be available from July.

As well, you can download many classroom activities and suggestions to help you successfully use C@S. Students can generate their own random samples or prepared samples can be downloaded from the website. Although extracting their own sample is more time consuming, the possibilities that this creates for better understanding of concepts such as randomness, variability, sample size etc. often make it worthwhile, especially for older students.

The examples below show some further ways this data can be used to engage students and improve statistical understanding across many year levels.

\* This paper has not been peer-reviewed.

## Years 7 and 8

To produce, understand and interpret tables and graphs of various types is a consistent curriculum requirement across all states and territories. C@S allows you to address these requirements, engage your students and improve their understanding. As well as the suggestions on the website, there are many questions that you can explore with your students while they learn about data. For example: How do students get to school? Does this change as students get older? Are there differences between boys and girls? (See Figure 1.)

Because there is such rich and varied data in the C@S resource, it also helps your students understand why particular graphs are appropriate in some circumstances but not others. When students have to make these decisions themselves, they develop a deeper understanding of statistical ideas.

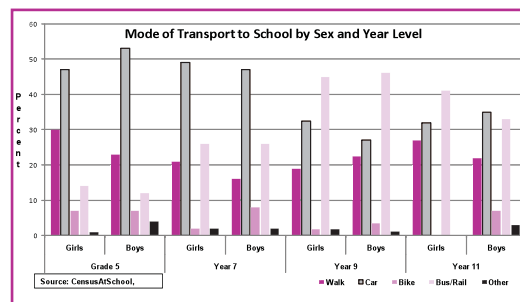


Figure 1

## Years 9 and 10

By the end of Year 10 your students have been asked to grapple with a number of potentially difficult statistical concepts. The CensusAtSchool resource allows these concepts to be explored using data that makes sense to the students and with which they can identify. For example the difference between population and sample, and hence the idea of “random”. Simply having each of your students generate their own sample from the C@S Random Sampler powerfully demonstrates how the summary statistics cluster even though all students will have drawn a different sample.

Outliers (what they are, how they affect data and what to do with them) can also be a difficult concept for your students. The CensusAtSchool data has not been “cleaned”, so it includes outliers (as well as missing values). Students need to make decisions about what should be discarded, and this encourages them to ask questions of statistical data, not just follow formulae. These decisions are aided by plotting the data (eg finding the interquartile range with a box plot), but they cannot be entirely answered with mathematics. Students are often uncomfortable making non-mathematical judgements in a maths classroom, but the C@S data helps them make sense of these issues. No-one is 1.5 cm tall for example, or has their belly button higher than their height. Students can also examine the effect of outliers on the mean, median and mode with real data which helps them recognise how one individual value can influence measures of central tendency (see Figures 2 and 3).

CensusAtSchool includes both categorical and (continuous) numeric data, and

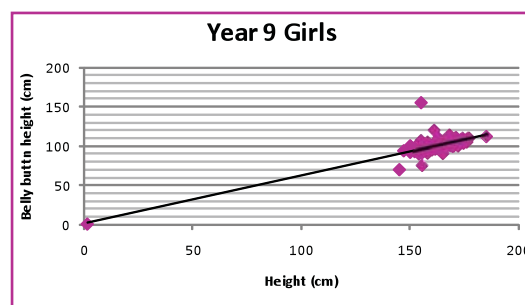


Figure 2. Graph with outliers included.

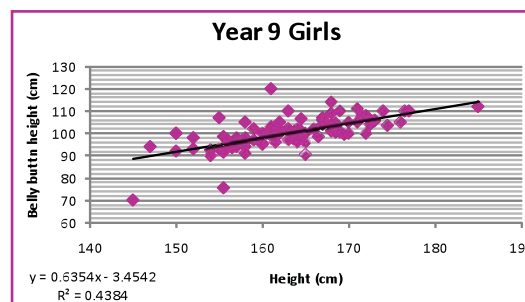


Figure 3. Graph with outliers excluded.

there are a number of questions that lend themselves to looking at relationships. Does eating breakfast improve reaction times? Is there a relationship between height and arm span? (See Figure 3.)

## It is easy—and free—to participate

### Register

Set up a Teacher Account at [www.abs.gov.au/censusatschool](http://www.abs.gov.au/censusatschool) —it will only take about five minutes. Generate Student Access Numbers (SANs) for your students and you are ready to go. (If you have registered in previous years, all you need to do is generate SANs for your students from your Teacher Account.) Download the printable version of the questionnaire for your own records.

### Prepare

Explain to the students that they will be completing an online questionnaire that thousands of other Australian students have already completed. Afterwards they will be examining the data to make comparisons between year level, boys and girls and, for some variables even different countries.

Have your students measure their height, arm span, foot length and distance from their belly button to the ground. They will need these measurements to submit the questionnaire.

### Complete the online questionnaire

Give each student their unique SAN and they are ready to complete the online questionnaire. If you collect your own class data you can then compare your class with others.

### Finding stories in the data

As well as using the examples above, or those from the webpages, do not forget to ask students what they think they can find out from the information? What questions can they ask? Your students may need some prompting, but this is a very powerful technique. It not only gets students owning their work and enjoying it, it also reinforces that statistics is as much about asking sensible questions as it is about finding appropriate answers.

Some ideas to start your students off include: Who has the faster reaction time: girls or boys? Who was quicker completing the concentration game: girls or boys? Are Grade 5 students as quick as Year 9 students? How do most students get to school? Is this different for boys and girls? Between different grades? How does this class compare with students of the same age around Australia? In other countries? What are students' attitudes to some environmental questions? Are these constant across ages and time (compare 2006, 2008 and after July, 2010 as well)?

So register now and show your students that statistics can be fun! For further information, contact the ABS Education Services Unit at [censusatschool@abs.gov.au](mailto:censusatschool@abs.gov.au) or free call 1800 623 273.

## References

- Jordan, J. & Haines, B. (2006). The role of statistics educators in the quantitative literacy movement. *Journal of Statistics Education*, 14(2). Accessed 21 March 2007 at <http://www.amstat.org/publications/jse/v14n2/jordan.html>.
- Nicholson, J., Ridgway, J. & McCusker, S. (2006). Reasoning with data — Time for a rethink? *Teaching Statistics*, 28(1), 2–9.